NOTES ON THE BIOLOGY AND MORPHOLOGY OF THE *EURYMELINAE* (CICADELLOIDEA, HOMOPTERA).

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(Plate xi; nineteen Text-figures.)

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Introduction.

The Eurymelinae, which comprises a group of insects entirely confined to Australia and the neighbouring islands, has up to the present time been regarded as a division of the Bythoscopidae, owing to the facial position of the ocelli, though it differs from true members of that family in possessing broad flap-like subgenital plates with apical spine-like styles, quite distinct from the narrow plates found in the Bythoscopidae. In fact China (1926) considers that the group merits elevation to family rank.

The insects which form the subject of this paper belong to the Eurymelini division of the Eurymelinae; they may be distinguished from the other division of the group, the Pogonoscopini, by the following characters. In the Eurymelinae the hind tibiae are quadrilateral in section and have distinct spur-like teeth, with mobile spines at their apices, while in the Pogonoscopini the hind tibiae are rounded in section with the outer sides flattened, and bear a regular armature of spines arising direct from the tibiae themselves.

The first description to be published of an insect belonging to this tribe appeared in 1825 (Le Pelletier and Serville, 1825) and from that date to the present day descriptions of new species have appeared from time to time in the scientific periodicals of other countries. No great interest appears to have been taken in the group by Australian entomologists, the first mention of it in Australia being made in 1906 by Froggatt (1906, p. 355) who made the justifiable error of considering them to be members of the family Cercopidae.

Since the types are scattered and some of the descriptions hardly worthy of the name, at the moment great difficulty attends the identification of any but the commonest species. Although neglected by entomologists in this country, these insects are by no means rare, being found principally on small eucalyptus trees in open country, and as the coloration of many of the group is bold, and they are usually found in fairly large numbers together, their observation and collection is a comparatively simple matter.

This paper is offered as a preliminary to further studies, which I hope to carry out in the future on the biology and morphology of this and related groups of insects.

Life-History.

The habits of the different species are uniform, and since it has been found impossible, owing to lack of time and opportunities, to trace through the detailed

life-cycle of any one species, a composite account has been built up, the species concerned being named in every case. The observations recorded have all been made in the neighbourhood of Canberra.

Oviposition.—Oviposition takes place principally in October and November, the eggs being laid in parallel slits made in the bark of young branches of eucalyptus trees. The manner in which the slits, or nests, of the different species are sealed varies considerably. Although a number of types have been found, it so far has been possible to discover the identity of only two of the species concerned.

The nests of *Eurymeloides pulchra* Sign. are cut in rows parallel to the axes of small branches, the twigs chosen usually being from five to ten millimetres in diameter. Each nest is covered by a narrow band of a hardened frothy secretion. Nests of *Eurymela distincta* Sign. are even better protected, since here the hardened froth is extended to form large flaps, each one overlapping the adjacent flap. In Plate xi, figure 1, are shown the nests cut by an unidentified species.

Probably every species is confined to one or a few host-plants, but so far the records are too scanty to pronounce with any certainty on this point. However, the author has only found *Eurymela rubrovittata* A.S. on *Eucalyptus melliodora*; *Eurymeloides pulchra* on *E. Blakeleyi*, and *Eurymela distincta* on *E. Bridgesiana*. Trees belonging to the genus *Eucalyptus* are not the only host-plants, nymphs of two as yet undetermined species having been found in numbers on Casuarina trees, and probably further collecting would even further increase the list.

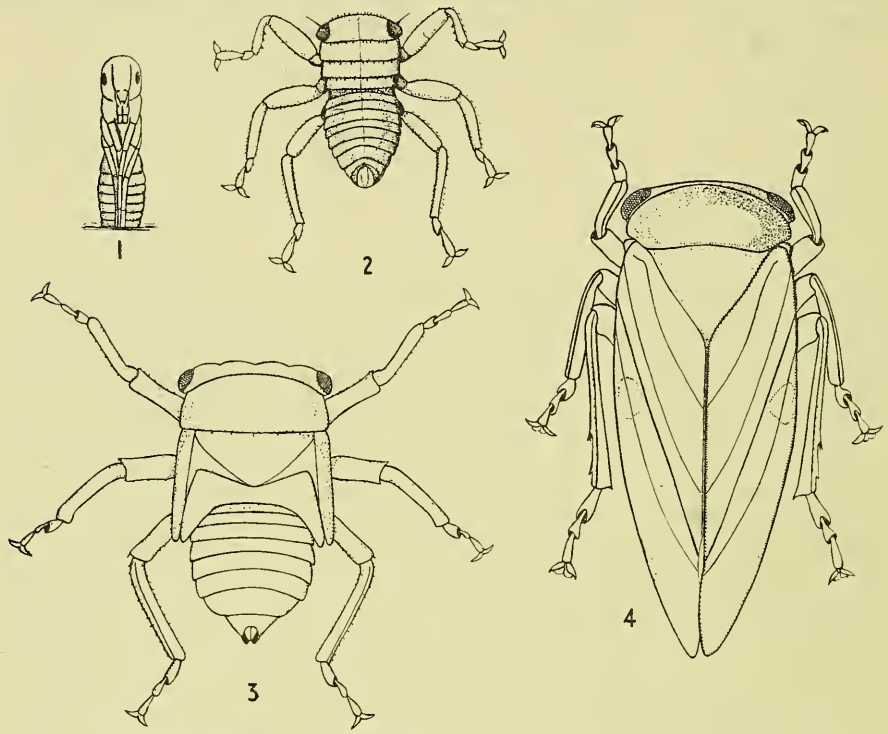
Hatching.—The act of emergence from the nests has been observed only with *E. distincta* and an unidentified species. The lower half of each egg is enclosed by a sheath constructed by the female when ovipositing. The eggs, of which about twelve are contained in a nest, are white in colour, long, and slightly curved, those of *E. distincta* being two millimetres in length. At first they are rounded at their anterior ends, but prior to hatching this end becomes pointed and contains a hard white waxy substance which gradually increases in size and density. This plug protects the delicate pronymph, and is used as a ram for pushing through the plant tissue, since the eggs are deeply embedded in the bark. When the anterior third of the egg has emerged from the bark the plug breaks up into a yellowish fluid, and the head of the pronymph appears beneath the chorion, which then splits. If an egg is dissected out of the plant, and the white plug is removed, the head of the pronymph, which contains a pulsatile sac, at once protrudes.

The pronymphs, which are colourless but for their red eyes, rise out of their nest with a lunging motion, and when about three-quarters emerged, split their skins anteriorly, so that the nymphal heads appear (Plate xi, figs. 2 and 3). These begin to swell at once, and in a short space of time the nymphs free themselves from their exuviae. Though colourless at first, they turn completely black in less than fifteen minutes, and then at once begin to feed. It is doubtful whether the whole complement of a row of eggs ever gives rise to nymphs, since the first pronymphs to leave a nest invariably crush their less pushing, and consequently less successful, neighbours.

Nymphal Instars.—The nymphs may be found abundantly during the months of November, December and January. They are gregarious at all stages, but especially during the early ones, when they congregate at the base of the season's growth of eucalyptus branches, and in the axils and along the stems of neighbouring young leaves (Plate xi, fig. 4).

They stand with their legs spread out to their full extent, their bodies being closely pressed to the plant. If disturbed, they dodge round the branch, so as to

put it between them and the intruder, and if again molested run off at great speed up or down the branch, eventually returning to where their companions are feeding together. They then push their way in among the other nymphs, until they discover a bare bit of branch in which to insert their stylets. They never jump when disturbed, their legs being adapted for clinging, not leaping.



Text-fig. 1.—*Eurymela distincta* Sign., pronymph.
Text-fig. 2.—*E. distincta,* nymph, first instar.
Text-fig. 3.—*E. distincta,* nymph, fifth instar.
Text-fig. 4.—*E. distincta,* adult.

There are five nymphal instars, exclusive of the pronymph. The adult coloration appears, as far as *E. distincta* is concerned, in the second instar. The first instar nymphs of this species are spider-like creatures, entirely black, but for the eyes, which are red, and the ventral surface of the abdomen, which is white. Nymphs in the second instar are not so squat but more elongate, and have red abdomens, similar to the adults. In the middle of each sternite at this stage and in the following three instars, is a grey area dotted with six to eight pits, presumably of a sensory nature. These do not occur in the final instar.

Later Life-History.—In the Federal Capital Territory there is probably only one complete generation a year of *E. distincta* and *E. rubrovittata.* Some of the smaller forms, such as *Eurymeloides bicincta* Erichson, have two generations, the eggs that give rise to the second one being laid in February. First instar nymphs of *E. pulchra* have been found as late as April, but doubtless they are killed by the

early frosts. During the summer the adults congregate on the trees on which they have spent their youth, but in the autumn a number migrate to new surroundings. Adults of both sexes of *E. distincta* and *E. pulchra* have been found in April resting on the sides of buildings away from any possible source of artificial light, and quite five hundred yards from the nearest eucalyptus trees. During May many have been collected on windows, attracted there by the light, but by the end of this month all the surviving adults have stopped feeding and gone into hibernation under the bark of trees, although a few will emerge from their concealment on a particularly warm sunny day during the winter.

In September and October mating takes place. This is preceded by a lengthy courtship, which has been observed between individuals of *E. rubrovittata.* A male sits astride a female, grasping her just in front of the anterior edges of her forewings with his middle pair of legs. With his fore tarsi he taps her head with light touches, and with his hind legs strokes her wings, every now and then vibrating excitedly both pairs of legs. The males are frequently anxious to mate before the females are receptive, so that the courtships are often unproductive of results.

The females continue to oviposit over a long period, and during this time it is doubtful whether they leave the tree, or even branch, first selected for the reception of their eggs. It is not known how often mating takes place, but every female, whether actually ovipositing or resting between bouts of arduous labour, waiting for her next batch of eggs to mature, is accompanied by a single male. Often many isolated colonies are found on one tree, consisting of a pair of adults and numerous nymphs.

Adults of some species retain the gregarious habits found throughout the tribe during the nymphal stages. Large colonies of *E. distincta* have frequently been found sitting along a branch, and, if one is disturbed, it will first move round to the other side of the branch, and then, if again approached, will leap away, taking to flight when in mid-air. Generally they do not fly far, but wheel round and return direct to the same tree.

Feeding Habits.—Although the nymphs feed only on tender shoots, the adults are able to obtain nourishment from more woody tissue. When a nymph commences to feed, its whole body is moved rhythmically up and down, the abdomen being bent slightly forwards and downwards, and the thorax pushed forwards, as if to force the mandibles into the plant tissue, the whole weight of the body being used for this purpose. A third instar nymph of *E. pulchra* has been observed almost to pivot on its proboscis whilst feeding, first the hind two pairs and then one fore leg being raised, and the whole body twisted with a forceful screwing movement.

Adam White (1845), in a paper describing a "New Genus and some new species of Homopterous insects from the East", gives the following note about the feeding habits of these insects: "With reference to the genus *Eurymela* I may mention that Mr. Harrington of Bath informed me that in New Holland the different species are named 'manna-flies'. They bore into the green bark of the gum trees (Eucalypti), the sap exudes, dries and falls to the ground, sometimes in great quantities. This gum-tree 'manna' is sweet to the taste."

Probably Mr. Harrington confused certain Psyllidae with the Eurymelinae, since "manna" is not produced through the agency of the latter group, but by Psyllids of the subfamily Aphalarinae. Froggatt (1906, p. 364) remarks that insects of the genus *Spondyliaspis* form "sugar lerp scales", which often encrust

the foliage of young gum trees, and are sometimes so abundant that the blacks used to collect it in quantities and have a regular manna harvest.

Relationship with Ants.

Colonies are invariably attended by ants, which feed on the "honey-dew" ejected from the anal aperture. This is nothing more than the excrement and not the secretion of any special gland. A great quantity of this "honey-dew" is produced, and since this is very sticky, the young nymphs would probably get caught in it were it not for the services of the ants.

In captivity, ants have frequently been seen trying to carry off nymphs of *E. pulchra* that had fallen on their backs. The results of their efforts were usually merely to put the nymphs on their legs again, whereupon the ants lost interest in them. On one occasion an ant was seen carrying a last instar nymph of *E. rubrovittata* down a tree trunk. When captured, it immediately dropped its prey which was found to be unharmed.

It is interesting to conjecture whether the even more intimate relationship of ants with the Pogonoscopini, which are confined to Western Australia, may not have arisen in some such way, the nymphs being taken from the branches and transferred to the trunk of the same tree beneath the soil. Mr. D. C. Swan, of the Department of Biology of the University of Western Australia, forwarded to the writer in September, 1930, some specimens of *Pogonoscopus myrmex* China, taken in the nest of *Camponotus testaceipes* Sm., built against the trunk of a eucalyptus tree (*E. redunca*, var. *elata*). Mr. Swan, in a letter accompanying the insects, mentioned that the nest which consisted of tunnelling amongst loose bark at the base of the tree, contained all stages of the insect, living quite freely with the ants. Also that *E. redunca* has a smooth clean bark without any great development of cork, and it would seem that the Pogonoscopids sucked up sap from it just below ground level. Mr. J. Clark, of the National Museum, Melbourne, has observed that when insects of this tribe are attended by species of *Iridomyrmex* they are nearly always found on the shoots of plants, very rarely in the ants' nests, excepting with *I. nitidus* Mayr. The following species of ants have been found attending *Eurymela* colonies round Canberra: *Iridomyrmex detectus* Smith, *I. rufoniger* Lowne, *I. nitidus* Mayr, and *Dolichoderus* (*Hypoclinea*) *scabridus* Roger.

Natural Enemies.

Although it has been stated earlier in this paper that these insects are not rare, yet considering the abundance of their food-plants, their distribution is localized, and no doubt their numbers fluctuate greatly from year to year, due to the control effected by their numerous parasites.

In December, 1930, in the neighbourhood of the Entomological Laboratory at Canberra, a branch of an *E. Bridgesiana* tree was found badly scarred by the egg-slits of *Eurymela distincta*, the incisions extending over a length of sixteen inches. The scarred part of the branch varied in diameter from thirteen to five millimetres. There were thirty-four rows of slits cut all along one side of the branch; each row was made up of from one to fourteen nests, the average distance between the nests being six millimetres. The branch was green, but the areas round the nest had turned brown. Every nest was examined, and it was found that very few eggs were unparasitized. The majority had turned brown, and contained on an average five small hymenopterous pupae, while others

were black and contained one pupa each of somewhat larger parasites. Altogether three species of Chalcidae were bred from these eggs.

In some of the nests, more than half of the eggs had been eaten by the larvae of *Oscinosoma luteohirta* Mall. (Diptera, Chloropidae). The pupae of these flies were also found in the nests; they were very flattened owing to lack of space, and it is difficult to imagine how the flies contrive to emerge from their position under the bark.

During January, 1931, a second instar nymph of an unidentified species was found with a Dryinid larva attached to its thorax. The host was quite active, although the parasite was bulky, being fully half the size of the former. On three occasions parasitic larvae have been found in the abdominal cavities of *E. distincta*. These were shown to entomologists with a wide experience of dipterous and hymenopterous larvae, who were not able to assign them with any certainty to any Order.

Both adults and full-grown nymphs of *E. distincta* have occasionally been found with flattened white sacs lying along the sides of their bodies, these being completely hidden by the wings of the adult hoppers, and partly concealed by the wing-cases of the nymphs (Text-fig. 8). The sacs contained very flat lepidopterous larvae, lying with their heads towards the posterior ends of their hosts. At first it was considered that the sacs were cocoons, which they certainly resembled, but when a female adult hopper bearing two sacs, one on each side of its thorax and abdomen, was confined in a breeding cage, next day the sacs were empty, containing only cast larval skins, the larvae being discovered wandering about the cage. These were peculiar little objects, oval in shape, with the dorsal surface red. Each segment bore a projecting white flap, having four spines on the under surface. Inwards from these flaps, on the ventral surface, were sclerites, the pleurae, each of which bore a group of six spines. The larvae were able to move with great rapidity, due to the fact that the claws on the fore legs were modified to form adhesive pads. Unfortunately both larvae died without pupating.

Although no moths have been bred out, it may be assumed that the larvae belong to the family Epipyropidae, the larvae of which have been recorded as being parasitic on Homoptera in many parts of the world. Without further data available, it is difficult to determine the exact relationship between parasite and host. Perkins (1905) considered that it was probable that the larvae fed on the "honey-dew" produced by the Homopteron, and not on the waxy secretion as was thought by many of the earlier writers. The same author mentions that Koebele, from observations made at Sydney, believed that the hoppers died soon after the parasites quitted them, and he himself noticed that in some cases, at least with *Agamopsyche* at Cairns, death followed quickly on the withdrawal of the full-fed caterpillar. Even immediately after this event in specimens of a Delphacid, a collapse or distortion of the dorsal sclerites of the abdomen was obvious, and healthy hoppers included in the same jars as parasitized ones outlived the latter.

It is possible that the cocoon-like sacs serve to protect the larvae from being molested by ants, and are analogous with those made by Psychid larvae, which half emerge from their cases when feeding, but dart back at the slightest alarm, and since the aperture of the sacs is close to the anal opening of their hosts, it may be presumed that they feed on "honey-dew". Although the insect already referred to, which bore a parasitic larva on each side of its thorax and abdomen,

died the same day as that on which the larvae left it, yet frequently adults have been taken in the field with empty sacs attached to them, which appeared to be equally as vigorous as their unburdened companions. It is doubtful whether predators take any toll of the nymphs, since ants resent any interference with their charges, and fiercely attack an intruder.

Comparison with Membracidae.

The Eurymelinae have very different habits from those of the majority of the Cicadelloidea, though they are somewhat similar in this respect to the Membracidae. The following characteristics of the last-named family, given by Funkhouser (1923), would equally well apply to the Eurymelinae:

(i) They are principally tree and shrub inhabiting insects.
(ii) They are found most often on plants growing in open country, not in shady woods.
(iii) The adults of many species have the habit of arranging themselves in rows on the branches of trees.
(iv) The nymphs are usually found pressed tightly in the axil of a leaf, or a crotch of a twig.
(v) Some species are definitely gregarious.
(vi) If approached, an insect will often move round to the opposite side of the twig or stem, and make no attempt to fly, except as a last resort to enable it to escape.
(vii) They invariably return to the same host from which they have been disturbed.
(viii) A large number of species are attended by ants, the latter insects collecting the so-called "honey-dew", excreted from the anus of both nymphal and adult forms.
(ix) The eggs are laid in incisions made in the bark of young stems.

Although it is not suggested that these common characteristics indicate any very close degree of relationship, yet they are probably due to more than mere chance convergence, being possibly primitive characters retained by members of both groups.

Economic Importance.

These insects cannot be considered of any economic importance. Occasionally tender young eucalyptus shoots are found that have wilted, due to the feeding of numerous nymphs at their base, and it is possible that the scars on twigs, made by the females when ovipositing, might sometimes cause the death of the injured twig. However, now that eucalyptus trees have been spread by man all over the world, it is not inconceivable that these Homoptera, if accidentally introduced into other countries, and freed from their parasites, might become pests of some importance.

External Morphology.

The coloration of some of the members of the tribe is very striking. The eyes may be black, orange or red; the pronotum and scutellum totally black, or black with orange, yellow, or red markings. The forewings which are frequently opaque and coriaceous have, in the more typical members of the division, two large irregular white or coloured areas, and vary from a blackish-purple to black or bronze, while the abdomens are black, yellow, green or red.

The less conspicuous species are pale-brown, chocolate, or blackish, with indistinct patterns on the wings, while the wedge-shaped insects belonging to the genus *Ipo* have transparent forewings. There is a fairly considerable range in size, the biggest species being about fifteen millimetres long, and the smallest five millimetres. The pigment causing the bright coloration of the abdomen in such species as *E. distincta* and *E. pulchra*, is carried in the hypoderm, the cuticle itself being colourless. Many species show a considerable variation in the relative size of the markings on the thorax and tegmina, and graded series can be arranged, the insects at each end being very dissimilar in detailed colour pattern.

Morphological studies have been made chiefly with *E. distincta*, so that, unless otherwise mentioned, the following notes refer to this species.

E. distincta is one of the largest insects of the group, the females being fifteen millimetres long from the apex of the head to the tip of the folded forewings. In order to give those readers of this paper who are not familiar with the group, some idea of the appearance of this species, a short description of it is given below.

Head: Black, excepting for the maxillary plates, and the outer halves of the lorae, which are white, the eyes, which are black, with a variable number of longitudinal white bands; and the labium, which is brown with a white tip.

Thorax: Pronotum and scutellum, black, the rest scarlet.

Forewings: With the exception of two irregular white spots, black with a purplish sheen.

Hindwings: Smoky grey, with an even more pronounced purplish sheen than the forewings.

Legs: Coxae, and the proximal halves of the femora, scarlet; the distal halves of the femora, the tibiae and tarsi, black, but for the first tarsal segments of the hind legs, which are white. Hind tibiae quadrilateral, two edges bearing rows of weak spines, one edge spineless, and the fourth bearing a spur, or occasionally two spurs, with mobile spines at their apices.

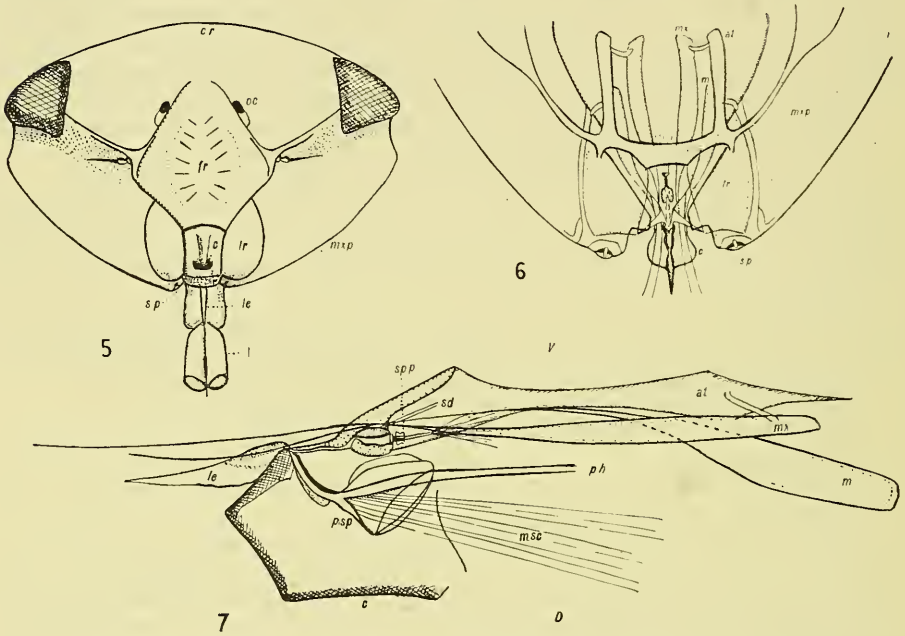
Abdomen: Scarlet.

Myers (1928) states that some of the most controverted questions in external insect anatomy have concerned the interpretation of Hemipterous head structure. The present writer is therefore content to leave the controversy to those more qualified to take part in it, and so only a brief description of the head, illustrated by text-figures, is given here, the nomenclature employed being taken from the paper on Cicadan morphology referred to above, which has been found invaluable for comparative purposes.

Head.—Viewed from in front, the head (Text-fig. 5) has a flattened appearance, and is considerably broader than long. The white genae (maxillary plates) which bear sensory pits on their anterior inturned margin, similar to those found in some Cercopids (*Philagra* sp.), occupy fully half the total area of the head. Overlapping these sclerites, and lying along the margin of the clypeus and frons, are the small lorae. The frons which is not appreciably swollen in this species, is diamond-shaped. The anterior edges of the genae, lorae and clypeus are bent at an obtuse angle to the rest of the sclerites, and lie parallel to the long axis of the body. The labium is three-segmented, the tip reaching the coxae of the middle pair of legs.

The sclerite lying above the frons is the crown or vertex. In the adult and last instar nymph of this species, there is no recognizable suture between these two sclerites, although one is present in the other nymphal instars. The crown

bears the ocelli, which lie along the edge of the frons. In the adult this sclerite lies entirely in a ventral position, but for a narrow dorsal border on a plane with the pronotum. As may be seen in Text-figures 2 and 3, the crown extends further dorsally in the nymphs. Although the epicranial suture is not visible



Text-fig. 5.—Head of *E. distincta*. *l.*, labium; *le.*, labium-epipharynx; *sp.*, sensory pore; *c.*, clypeus; *lr.*, lorum; *mxp.*, maxillary plate; *fr.*, frons; *oc.*, ocellus; *cr.*, crown.

Text-fig. 6.—Anterior part of the head of *E. distincta*, viewed from behind. The two maxillary plates have been separated at their junction; the lorae are from this view-point beneath the maxillary plates. *mx.*, maxilla; *at.*, maxillary apodeme; *m.*, mandible; other lettering as in Text-fig. 5.

Text-fig. 7.—Median section through the part of the head shown in Text-fig. 6. *psp.*, pharyngeal sucking-pump; *msc.*, dilator muscles of pharynx; *ph.*, pharynx; *spp.*, salivary pump; *sd.*, salivary duct; other lettering as in previous figures.

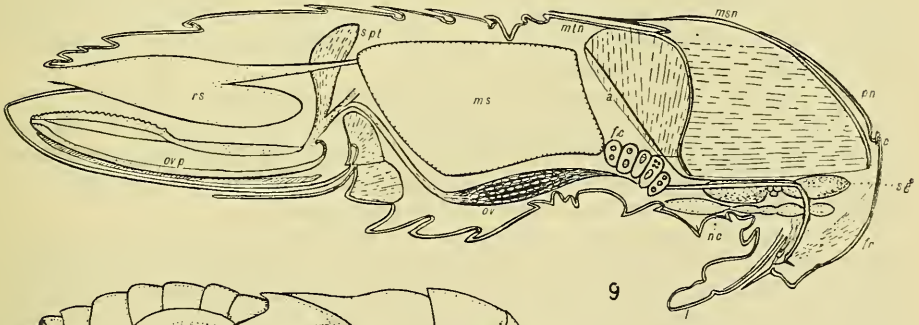
in adult insects, yet it is present in the nymphs, excepting for those in the fifth instar, and it is along this suture that the skin of the head splits at each ecdysis. The lateral arms of the suture lie along the margin of the frons, and the stem of the Y runs posteriorly to the hind margin of the head. Before casting its skin, a nymph will firmly insert its stylets into the tissue of the leaf or twig on which it is resting. The old skin is thus anchored down, and remains attached to the plant after the insect has left it.

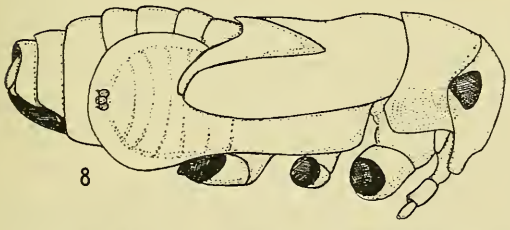
Text-figure 6 is a semi-diagrammatic representation of the lower (anterior) part of the head capsule, viewed from behind. The maxillary plates, which have been separated and pulled apart, in order to show the hypopharynx and salivary pump, lie on top (from this viewpoint) of the lorae. The body of the tentorium,

which for the sake of clarity is not shown, joins the apices of the maxillary apodemes. Each mandible is attached to the wall of the head capsule at the junction of a lora, maxillary plate and the frons. As will be seen from the diagram, their point of attachment does not lie so far back in the head as that of the maxillae.

Text-figure 7, also semi-diagrammatic, is a median section through the part of the head represented in the previous figure. The stylets are shown displaced, the mandible being freed from its connection with the head capsule. Actually the two stylets join the opposite pair at the meeting place of the pharyngeal opening and the efferent duct of the salivary pump, and then lie in a groove between the hypopharynx and epipharynx, and thence along the trough of the labium. The apposed stylets form a closed tube, the barbed mandibles enclosing the finer maxillae.

The pharynx consists at first of a highly chitinized tube, which leads into the sucking-pump. The pharyngeal muscles are inserted into the dorsal wall of the invaginated portion of the sucking-pump, the other ends being attached to the inner surface of the frons. The rest of the digestive system is described later, in the section dealing with the internal anatomy. Below the sucking-pump (above in the diagram) is the salivary pump. The following description of this organ given by Myers, though referring to the Cicadidae, is equally applicable here. "The salivary pump is a tiny but tough chitinous cylinder, or elongate bell of transparent material, lying beneath the trough-like frontal plate. The piston or plunger . . . . is darker in colour. The pump anteriorly continues into a narrow heavily chitinised tube opening near the mouth pore. Posteriorly the





Text-fig. 8.—*E. distincta*, last instar nymph, with attached parasitic lepidopterous larva.

Text-fig. 9.—*E. distincta*, vertical longitudinal section through a female, diagrammatically represented. The section was cut when the mesenteric sac was fully distended with air. *l.*, labium; *fr.*, frons; *c.*, crown; *pn.*, pronotum; *msn.*, mesonotum; *mtn.*, metanotum; *sg.*, salivary gland; *nc.*, nerve cord; *fc.*, filter-chamber; *a.*, aorta; *ov.*, ovary; *ms.*, mesenteric sac; *spt.*, spermatheca; *rs.*, rectal sac; *ovp.*, ovipositor.

shaft of the plunger expands into two branches, each serving for the insertion of a wide but powerful protractor muscle."

Thorax.—The detailed morphology of the thorax has not been investigated. Viewed dorsally, the large pronotum and scutellum are the only visible sclerites. The prescutum of the mesothorax is entirely covered by the pronotum, and the prescutum of the metathorax, which is a bilobed plate, is bent at right angles to the scutum, the latter being overlapped by the scutellum of the mesonotum (Text-fig. 9).

Legs.—The legs are of interest, since it is owing to the fact that the hind tibiae of the majority of the species bear a few prominent spurs, and do not have rows of long spines, that they are so often mistaken for Cercopidae. The legs of the nymphs are long and spider-like, and since they do not jump there is no great development of the hind tibiae; these are relatively longer in the adults, which also have three instead of two tarsal joints on each leg, the extra segment being formed by the division of the ultimate nymphal ones.

Front Legs.—The interior sides of the front femora and tibiae each bear a row of spines with broad bases, no doubt of service to the insect in enabling it to retain a good grip of its food-plant. The second, third and fourth instar nymphs each have two rows of spines on the femora and one row on the tibiae; the fifth instar nymphs have two rows on both segments, as does also the adult, though those borne by the latter on the tibiae are greatly reduced.

Hind Legs.—The tibiae of the nymphs in the first three instars are rounded, and have many rows of small spines. Those of the fourth instar nymphs are quadrilateral in section, though the edges are not well defined. Each edge bears a row of spines, the outside ones possessing many more than the inside ones. The tibiae of the fifth instar nymphs are similar to those described for the fourth instar, but the spines are relatively shorter and their bases more protuberant, and the ridges of the segment better defined.

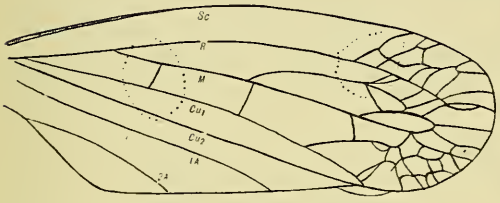
The number and arrangement of spines on the adult tibiae (Text-fig. 10) is somewhat variable. However, the ventral outside ridge invariably carries one or two large spurs with apical spines, and the dorsal ridge, though sometimes spineless, usually bears from six to eight small spines on its proximal half. The interior ridges each bear from three to six small spines.

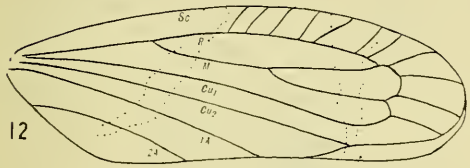
Venation.—Although the fore wings are thick and opaque, the veins are clearly visible. The venation is basically similar throughout the tribe, though there are two distinct types, one such as that of *E. distincta* (Text-fig. 11) and the other in which the apex of the wing, instead of being reticulate, has four or five large apical cells. *E. bicincta* is an example of the latter and more primitive type (Text-fig. 12). It is impossible to say definitely whether the subcosta actually occupies the position shown in the text-figures, or whether it is fused with the radius. It is even possible that it may be absent.

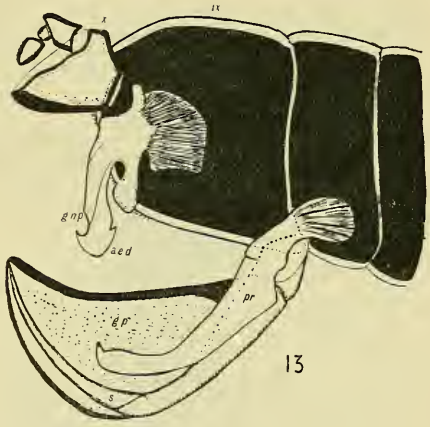
Wing Coupling.—The wing coupling apparatus is very simple. There is a small hook-like flap on the costal margin of the hind wing, just above the fork of the radius. This catches on to the thickened anal margin of the tegmen, the thickening extending nearly as far as the distal end of the claval suture.

Male Genitalia.—The male genitalia of this species (Text-fig. 13) have previously been figured by Singh-Pruthi (1925), who gives the following description of them: "Basal plates small, fused with each other, forming a transverse plate connecting the two parameres. Segmental membrane round the base of the aedeagus very stout, fairly wide, especially in the proximal region, with a stout

dorsal outgrowth from the base; the latter free of the segmental membrane, and therefore not corresponding to the basal strut in the above forms. Parameres long and stout. Subgenital plates very large, leaf-like, bearing each a style-like process in the distal region."







Text-fig. 10.—Hind leg of *E. distincta.*
Text-fig. 11.—Forewing of *E. distincta.*
Text-fig. 12.—Forewing of *Eurymeloides bicincta* Erichs.
Text-fig. 13.—Vertical section through the male genitalia of *E. distincta. aed.,* aedeagus; *gnp.,* gonopore; *gp.,* sub-genital plate; *pr.,* paramere; *s.,* style.

Remarks.—"The reduction of the basal plates, thickening of the body wall round the aedeagus base, the fairly wide aedeagus, flap-like sub-genital plates, etc., remind us of the genitalia in the Cercopidae. However, the presence of the basal plates, though in a rudimentary condition, and the absence of a distinct periandrum, decide its relationship with the Jassidae."

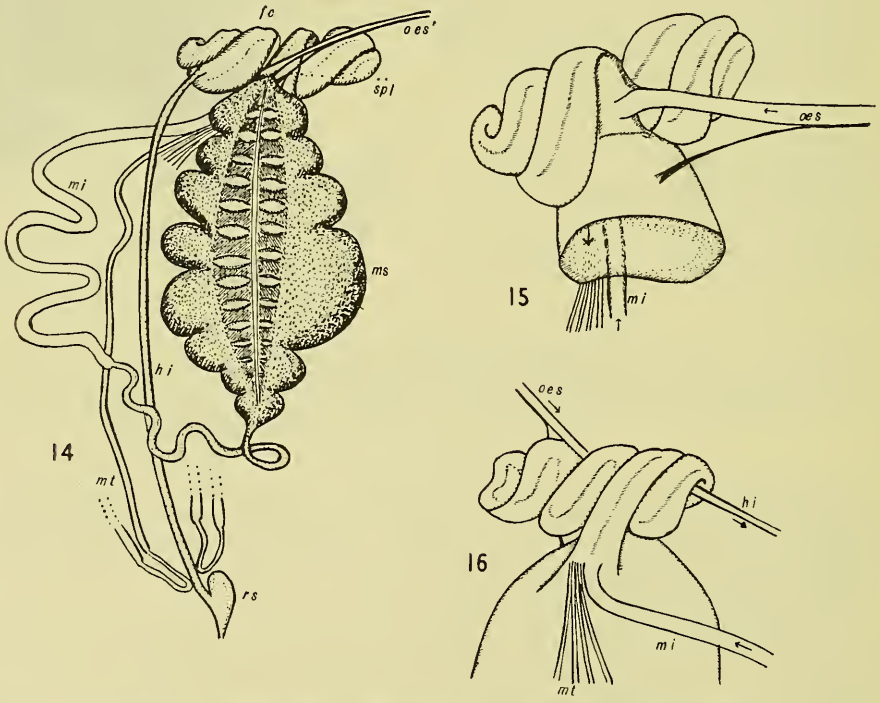
Female Genitalia.—The female genitalia (Text-fig. 9) conform to the normal type found in this family. They consist of three pairs of valves, the inner pair being fused along the greater part of their length, and forming the saw with which the slits cut in bark for the reception of the eggs are made. The one marked development in this species is that the seventh sternite is produced posteriorly into two large flaps, which reach from a point anterior to the base of the ovipositor to fully a third of its total length.

Internal Anatomy.

Digestive System.—The pharynx and sucking-pump have already been described. Posterior to the latter, the gut is a narrow chitinous tube, which

dilates just below the brain. To this swollen portion are attached numerous dilator muscles, and the anterior extremity of the aorta is intimately connected, apparently with the wall of this sac. At this point the oesophagus is bent, so that it runs at right angles to the fore part of the alimentary canal (Text-fig. 14). Posteriorly it enters the anterior lobe of the stomach. This lobe, the filter-chamber, is generally opaque, except in early summer, after the insects have emerged from hibernation, when it is more or less transparent. It is apparently coiled, this appearance being due to the fact that the stomach enwraps very closely the coiled and twisted hind part of the mid-intestine.

Licent (1912) has investigated this structure in a number of Homoptera, and remarks in connection with the family to which this insect belongs: "Chez les autres Jassidae [other than the Typhlocybinii], et chez les Membracidae, . . . la partie postérieure du médiintestin pénètre et serpente plus ou moins longuement dans la paroi d'un diverticule dorsal bien constitué, dépendant de la région antérieure; les régions proximals des tubes de Malpighi se comportent comme la partie postérieure du médiintestin, l'ensemble constitue un filtre qui évacue



Text-fig. 14.—Diagrammatic representation of the alimentary system of *E. distincta*, ventral view. *oes.*, oesophagus; *fc.*, filter-chamber; *spl.*, suspensory ligament of mesenteric sac; *ms.*, mesenteric sac; *hi.*, hind-intestine; *mi.*, mid-intestine; *mt.*, Malpighian tubes; *rs.*, rectal sac.
Text-fig. 15.—Ventral view of the filter-chamber of *E. distincta*. The coils on the right have been folded back to show the point of entrance of the oesophagus. Lettering as in Text-fig. 14.
Text-fig. 16.—Dorsal view of the filter-chamber. Lettering as in Text-fig. 14.

directement dans l'intestin postérieur la grande masse d'eau de sève". Figures 6 and 7, Plate xi, are microphotographs of longitudinal sections through the filter-chamber and mesenteric sac. The manner in which the stomach is folded round the mid-intestine is clearly shown in both photos, while in Figure 6 may be seen two Malpighian tubes cut through obliquely, and the narrow duct joining the filter-chamber to the mesenteric sac.

The posterior lobe of the stomach, here called, after Myers, the "mesenteric sac", is a large thin-walled sac, usually brown in colour, due to its contents. When at its normal size in the summer, its sides are folded, and the dorsal and ventral surfaces puckered into a series of small invaginations lying on either side of the median line. In the late summer and autumn, prior to hibernation, when the reproductive organs and accessory glands are small, the sac is so distended with air as to fill the entire abdominal cavity, so that the other organs are squeezed against the body-wall.

From the base of the sac the mid-intestine ascends, the proximal third being narrow and colourless. The distal two-thirds are wider, and finally, together with the four Malpighian tubes, enters the filter-chamber (Text-fig. 16). The point of attachment of the Malpighian tubes to the gut is hidden. For the greater part of their length they are white in colour, though the two extremities are transparent. The hind-intestine emerges laterally from between the coils of the filter-chamber, and runs straight to the rectum, the rectal sac being large and pear-shaped. The distal extremities of the Malpighian tubes are joined in pairs. The loop formed by the junction of each pair lies against, and is superficially attached to, a side of the hind-intestine anterior to the rectum. Licent (1911) has shown that the Malpighian tubes among the Homoptera terminate in a number of different ways, the type here described being of the same nature as that shown by this author to be present in *Macropsis lanio*.

Salivary Glands.—The salivary glands (Text-fig. 17) are paired organs, lying on each side of the head, and extending well into the prothorax. They have three component parts; a large semi-opaque bilobed gland, at the junction of the lobes of which lies a more transparent gland, consisting of a number of lobules, and a filamentous gland joined to the bilobed one close to the point of attachment of the salivary duct. The salivary ducts from each side of the head meet just behind the salivary pump. The two ducts join to form a single short canal which enters the pump on its ventral side.

Pseudovitellus.—Lying along each side of the abdomen is a long flattened gland with three constrictions, which divide it up into four connected parts. This gland, which is surrounded by fat-body though quite distinct from the latter, is pale-pink in colour and apparently ductless. The colour, and that of the testis, in this species is probably derived from the same substance as that which colours the abdomen scarlet. The gland, presumably the pseudovitellus, is regarded by some authors as being nutritive, and by others as having an excretory function.

Physiology.—A clear account of the mechanism of feeding and physiology of the Cicadidae, which applies equally well to these Homoptera, is given in the paper by Myers already referred to (pp. 450-453).

Saliva is forced down the smaller of the two channels formed by the apposition of the maxillary stylets. If an insect is held for a moment between finger and thumb, it will exude a drop of saliva. The plant-sap is drawn up the other larger maxillary channel by the action of the pharyngeal sucking-pump. From the oesophagus it enters the filter-chamber through the oesophageal valve. The filter-

chamber is sometimes found lying transversely along the top of the mesenteric sac as in Text-figure 14, and sometimes projecting into the thorax, the coils then being at right angles to the other position. It has been noticed that although the filter-chamber is a dense white colour, and does not take up stain (methylene-blue) like the rest of the gut, yet in insects that have reproduced and have not much longer to live, it is transparent and flaccid.

What exactly happens to the sap in the filter-chamber is somewhat uncertain. The generally accepted hypothesis is that the food is here separated by osmosis into the more liquid portion consisting of water and excess sugars, which passes direct into the hind part of the mid-intestine, and the more solid portion which enters the posterior division of the stomach, the mesenteric sac. The mesenteric sac, which is lined with digestive epithelium, leads from its base into a narrow tube, also absorbent, and digestive. The distal, wider and longer part of this

Text-fig. 17.—Salivary gland of *E. distincta.*

Text-fig. 18.—Male reproductive organs of *E. distincta,* prior to the swelling of the vesiculae seminales. *t.,* testis; *vd.,* vas deferens; *vs.,* vesicula seminalis; *acg.,* accessory gland; *ejd.,* ejaculatory duct.

Text-fig. 19.—Female reproductive organs and ovipositor of *E. distincta.* *ov.,* ovary; *spt.,* spermatheca; *ac.,* accessory glands.

tube contains in its walls, large cells, which are filled with chalky granules. This part, which is excretory, enters the filter-chamber, and inside it joins the hind-intestine. The rectal sac is large, but the excrement is not expelled in a forcible manner, as with so many Homoptera.

Male Reproductive Organs.—The testes (Text-fig. 18) are large rosette-shaped organs, pale-pink in colour. Each testis in this species consists of a great many lobes, though those of *E. pulchra* have only eight. The vas deferens from each gonad runs into a large curved vesicula seminalis, which in the breeding season swells to such a size as to fill the greater part of the abdominal cavity. Before entering the ejaculatory duct, each vas deferens is joined at the base of the vesicula seminalis by a very long thin-walled accessory gland.

Female Reproductive Organs.—The oviducts from the two ovaries (Text-fig. 19) are short. Posteriorly they join to form a common oviduct or vagina, along each side of which lies a kidney-shaped accessory gland. Just before reaching the base of the ovipositor, the vagina is joined by the spermatheca, and immediately posterior to this is the termination of a very long unpaired accessory gland. Finally, lying anterior to the ovipositor, and attached to the base of the common vaginal and spermathecal canal, are paired, much-coiled filamentous glands. The spermatheca is a thick-walled muscular sac which, in insects that have just reached the last instar, is deflated and mushroom-shaped. Later, when it fills out, it is as shown in the figure. The unpaired accessory gland opens between the base of the inner pair of valves of the ovipositor. Possibly its function is to supply the froth with which the nests are sealed.

Nervous System.—The central nervous system consists of the brain, sub-oesophageal ganglion, and two other ganglia situated in the thorax, the hindmost of which passes posteriorly into a single cord, that splits into two on entering the abdomen. From the brain are given off laterally the big optic nerves, and from the anterior centre of each lobe, the ocellar nerves. The suboesophageal ganglion is longer though narrower than the brain, and is joined to the first thoracic ganglion by two stout connectives. This ganglion is separated from the last one by a narrow waist. There is no aperture between the two masses, the hindmost of which is large and pear-shaped, and consists of fused thoracic and abdominal ganglia.

Taxonomic Notes.

It has already been mentioned that the present classification of this Tribe is in a very unsatisfactory state. The late Professor C. F. Baker had prepared a tentative classification, but this was never published. Mr. W. E. China of the British Museum has lent the present author a manuscript key to the Tribe, prepared by him in 1926. With the aid of this key and the co-operation of Mr. China, it is hoped that it will shortly be possible to undertake the work of revision. This will entail the splitting up of the present genera into a number of new ones.

It is apparent that the larger forms at present grouped together in the genus *Eurymela* L. and S., are more specialized than the smaller ones now placed in the genus *Eurymeloides* auctt. Among the primitive characters of the latter genus, to which attention has already been drawn, are the simple venation, and the possession of eight lobes in each testis. It may be presumed also that the few spines and spurs borne on the hind tibiae of the larger forms, are evidence of specialization by reduction. Also the frons in the head of the smaller forms is

separated by a distinct suture from the vertex or crown, though this is not so in the adults of the larger species.

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EXPLANATION OF PLATE XI.

1.—Eucalyptus twig, showing the arrangement of the nests of an unidentified species of *Eurymeloides*.

2.—Closer view of the same twig as shown in Figure 1, to show the heads of the emerging pronymphs.

3.—Last stage in the process of hatching, showing three pronymphs, and a nymph which has just cast its pronymphal skin.

4.—Eucalyptus twig; the young nymphs feed at the base of the new growth.

5.—*Eurymela rubrovittata* A. and S.

6, 7.—Longitudinal sections through the filter-chamber and mesenteric sac of *Eurymela distincta* Sign.